C9-R4: SOFT COMPUTING

NOTE:

1. **Answer question 1 and any FOUR from questions 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

Time: 3 Hours **Total Marks: 100**

1.

a) Explain McCulloch–Pitts Neuron model?

b) What is the difference between hard computing and soft computing? Give two examples of both.

c) Discuss different techniques and applications of Soft Computing?

d) Explain concept of hidden layer in neural network. List its merits and demerits.

e) How membership function of a fuzzy set is defined?

f) Consider the following real variables from everyday life:

* Income measured in £UK.
* Speed measured in meters per second.
* A TV show measured in how much you are interested watching it.
* A meal measured in how much you like to eat it.
* A traffic light measured in what colour is on. In each case, suggest a fuzzy variable corresponding to these real variables. For which of these five variables the use of a fuzzy variable is not really necessary? Justify your answer.

g) List salient features of Genetic Algorithms (GA).

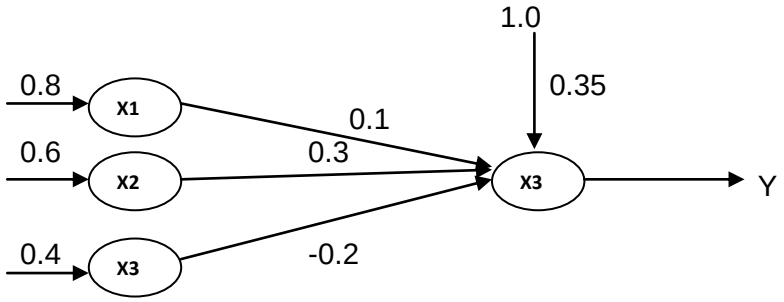
(7x4)

2.

a) Obtain the output of neuron Y for the network shown in figure below using activation function:

i) binary sigmoidal

ii) bipolar sigmoidal



b) Explain Backpropogation algorithm with two phases.

([3+3+3]+9)

3.

a) Explain in detail Neuro-Fuzzy system with Pseudo outer-product-based fuzzy neural networks.

b) Illustrate derivative based vs. derivative free optimization techniques.

(8+10)

4.

a) Consider the problem of finding the shortest route through several cities, such that each city is visited only once and in the end return to the starting city (the Travelling Salesman problem). Suppose that in order to solve this problem, we use a genetic algorithm, in which genes represent links between pairs of cities. For example, a link between London and Paris is represented by a single gene 'LP'. Let also assume that the direction in which we travel is not important, so that LP = P L.

   i) How many genes will be used in a chromosome of each individual if the number of cities is 10?

   ii) How many genes will be in the alphabet of the algorithm?

b) What is the purpose of defuzzyfication? Name at least one method used for defuzzyfication.

(9+9)

5. Suppose a genetic algorithm uses chromosomes of the form 'x = abcdefgh' with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual x be calculated as

$f(x) = (a + b) - (c + d) + (e + f) - (g + h)$, and let the initial population consist of four individuals with the following chromosomes:

x1 = 6 5 4 1 3 5 3 2
x2 = 8 7 1 2 6 6 0 1
x3 = 2 3 9 2 1 2 8 5
x4 = 4 1 8 5 2 0 9 4

a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

b) Perform the following crossover operations:

   i) Cross the fittest two individuals using one–point crossover at the middle point.

   ii) Cross the second and third fittest individuals using a two–point crossover (point's b and f).

   iii) Cross the first and third fittest individuals (ranked 1st and 3rd) using a uniform crossover.

c) Suppose the new population consists of the six offspring individuals received by the crossover operations in the above question. Evaluate the fitness of the new population, showing all your workings. Has the overall fitness improved?

d) By looking at the fitness function and considering that genes can only be digits between 0 and 9 find the chromosome representing the optimal solution (i.e. with the maximum fitness). Find the value of the maximum fitness.

e) By looking at the initial population of the algorithm can you say whether it will be able to reach the optimal solution without the mutation operator?

(4+3+4+4+3)

6.

a) Name three strengths and three weaknesses of fuzzy expert systems.

b) Explain Neuro-fuzzy control system with application.

(6+12)

7.

a) Explain Expert control system.

b) Discuss Neurogenetic system with example.

(8+10)